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LECTURE

ON THE

APPLICATION OF CHEMISTRY

TO

AGRICULTURE,

DELIVERED AT FARNHAM, DECEMBER 17, 1846,

WITH

OBSERVATIONS ON ARTIFICIAL MANURES,

BY

J. C. NESBIT, F.G.S., M.C.S.L., &c.,

OF THE SCIENTIFIC AND AGRICULTURAL SCHOOL, KENNINGTON, LONDON.

PRICE THREEPENCE.

BIBLIOTHECA REGIA

LONDON:
JOHN HUNT, HIGH STREET, LAMBETH.
1847.

High Street, Lambeth, London, Jan. 1, 1847.

JOHN HUNT begs respectfully to inform his Friends and the Agricultural Public that he has entered into arrangements with Mr. J. C. Nesbit for the preparation of his Chemical Manures, and that he has likewise secured that gentleman's professional advice and assistance with respect to the qualities of all other Manures sold by John Hunt.

John Hunt is therefore prepared to sell in a pure state, in addition to Mr. Nesbit's Manures, Guanos, Nitrate of Soda, Sulphate of Ammonia, &c., &c.; and trusts that the assured purity of his articles will command an increased share of the patronage and support which he has hitherto so liberally received.

TO AGRICULTURISTS IN GENERAL.

"Having been requested by a great number of my Friends in the Agricultural World to prepare for them, in a state of purity, Manures suitable for various descriptions of Plants, I have declined myself to enter into the Business, but have made arrangements to give my professional advice and assistance to the house of Messrs. Hunt, of Lambeth, in the preparation of the same.

"I believe I can with confidence recommend this Firm to the notice of Agriculturists and Farmers in general; and I pledge myself to insure as much as possible, by my analyses and directions, the due purity and proper preparation of all the Chemical Manures, Guanos, &c., which may pass through the hands of Messrs. Hunt.

"Accurate analysis of all articles relative to manure is quite necessary. Some persons have got the idea, that "*anything*" will do for manure. The consequence is that the market is inundated with various kinds of refuse from chemical manufactories of not the slightest utility to vegetation. The farmer is often made the victim of either the ignorance or the design of the manure dealer. A sample of one of these kinds of *manure* was recently offered to a friend at £4 per ton. A sample was sent to me, when I found more than fifty per cent. was insoluble matter and moisture, and the soluble matter was common salt, *blue vitriol,* and some other equally worthless stuff. The value was not 5s. a ton!

"J. C. NESBIT."

"*Scientific and Agricultural School,*
No. 38, *Kennington-lane, Lambeth, near London.*"

OBSERVATIONS
ON
ARTIFICIAL MANURING,
BY J. C. NESBIT, F.G.S., ETC.

The subject of artificial manuring is of vast importance to the agricultural world. The time has past when farm-yard dung was considered to be the only proper dressing for land. Experiment has proved that many other substances derived from various sources have been beneficial to the soil; and analysis has shown that the matter thus found to be useful was in its constitution analagous to farm-yard dung, containing either wholly or in part the same constituents. Thus, guano, nitrate of soda, saltpetre, &c., have in turns been found to be useful as top dressings. But it is evident that a manure, to be really beneficial, ought, with few exceptions, to contain the whole of the materials of the crop for the growth of which the said manure is intended.

A mistake made by many parties has been, to imagine that artificial top dressings were to preclude or exclude the use of farm-yard dung, and to obviate the necessity of so much care and economy in its preparation. This idea cannot be too often refuted.

The first duty of the farmer is to prevent on his farm the loss of any substance which can its decomposition into manure reproduce vegetable life. For this purpose not only ought the litter to be well taken care of, but even the weeds, which will *sometimes* appear even in the best farms, should be made, by fermentation with mould in the corners of the fields, to contribute their share to the general stock.

The farm buildings should be furnished with shoots or spouts, to prevent the water from the roofs washing into the manure; the streams of water sometimes seen running through the mass of the manure should be turned into some other less destructive channel; the horse pond should be kept free from the too frequent irruptions from the farm yard of liquid manure, too valuable for the land to be employed merely for the purpose of poisoning the unfortunate animals which are compelled to drink it; the urine from the horses and cattle should be received into properly constructed tanks, whence it can either be carted directly on to the fields, or pumped in dry weather over the manure; the tank and the manure heap should periodically be furnished with gypsum, to prevent as much as possible the escape of ammonia; and every other available means should be made use of, to prevent the slightest waste.

But on the generality of farms, when all the manure has been made which the farm can give, a sufficiency is not furnished for the proper working of the farm.

It is in this state of things, therefore, that the farmer turns to extraneous sources for the purpose of obtaining manure; and top dressings, with various substances as stated before, have been tried with considerable success.

A somewhat confused and erroneous idea has prevailed in some quarters, that if a manure is not seen in its effects in a number of succeeding crops, that it is not one which the farmer ought to use.

The proper mercantile view of the question is, that if, in addition to the regular crop furnished by the ordinary supply of manure given to a field, an additional supply of artificial manure should give an increase of crop amounting in value to a certain per cent. more than the cost of the artificial manure, that the use of the latter manure will be profitable.

Thus, if the application of artificial manure, at the cost of 30s. per acre, including putting on, should give an increase of crop which would be sold for 45s., then the profit would be 15s. per acre, or 50 per cent. upon the outlay of capital, even if no result should be seen in the after crops.

That no injury may be done to the land, artificial manures should not be used indiscriminately, but should in their composition have some reference to the constituents of the plants which they are intended to manure.

To effect this object is a matter of the utmost importance to the farmer, and yielding to the request of numerous agricultural friends, I have undertaken to give my assistance to a mercantile house to insure the proper combination of ingredients and the purity of the articles employed. The manure which, from my analysis of the hop, I suggested to the farmers in January, 1846, has, with the exception of two cases,* been exceedingly successful, and has given great satisfaction to those farmers who made use of it. The testimony of some of these gentlemen will be found in the ensuing lecture. Subsequent researches have been made on the hop, which have suggested improvements in the manure.

Though in the preparation of these manures I have had the advantage of the opinion and experiments of a number of able agriculturists in various parts of the kingdom, in addition to the aid of chemical science, yet, as soils vary much, I would recommend no farmer to proceed otherwise than cautiously in expending money upon them.

If experiments this year upon a few acres be successful, the breadth of land manured with them another year can easily be increased.

The turnip manure I think can with confidence be recommended to any extent, as it has been tried with success in many quarters.

The aid and assistance of agriculturists is much required for the purpose of solving the most interesting problem of the day, viz., the production of an increased amount of food; and I therefore trust that all who may happen to try these manures will not fail to keep accurate accounts of the results, and of the manner of using, dates when used, nature of soil, &c.; and if these accounts, favourable or unfavourable, could be transmitted to my address, a most valuable mass of evidence would be thus obtained.

And, in the meantime, any information on agricultural subjects, which it is in the writer's power to give, may be readily obtained on application, either personally or by letter, to Mr. J. C. Nesbit, Kennington, London.

ARTIFICIAL MANURES.

HOPS.

1. The manure for the hops will be prepared nearly as before, but with some important additions.
2. A second manure will also be prepared for hops grown on heavy soils, which are more likely to contain within themselves a fair supply of inorganic matter.

These manures may be had separately by designating them in the order of the numbers 1 or 2, as above. The price will be £14 per ton; and from 5 to 10 cwts. may be used per acre. They may be applied to the land from March to the end of June.

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* In one of these cases I procured from the gentleman the soil and subsoil of the field where the mixture I recommended had been used. The subsoil was absolutely devoid of *lime*, with the exception of a minute trace of gypsum. The surface soil contained little more than $\frac{1}{10}$ per cent., or 1 part in 1000, a quantity far too minute for the general purposes of the soil. This gentleman omitted one of the most important points of my recommendation, namely, that lime was a necessary ingredient for the hop, and that if deficient in the soil it must be supplied. I have recommended him to give his hop garden a good *liming*, or chalking, after which no dou can be entertained of the success of the manure I recommend. See "Nesbit's Analysis of the Hop," publi by Longman and Co., London.

MEADOWS AND PASTURES.

The manures for grass will be prepared for the purpose of furthering as much as possible a rapid and luxuriant crop. They will contain the necessary mineral ingredients, with a considerable supply of ammoniacal salts, so that they will adequately furnish to the land that which may be removed from it by the exportation of cheese, milk, or hay. The price will be £14 per ton ; and 2 cwt., 3 cwt., or 5 cwt. per acre may be employed according to circumstances ; and the dressing may be applied broadcast when the growth has fairly commenced.

CLOVER, LUCERN, SAINFOIN, &c.

Manures adapted for these plants may likewise be obtained ; price £14 per ton ; to be sown broadcast in the Spring, at the rate of 2 cwt. to 4 cwt. per acre, along with ashes or mould.

TURNIPS.

The manure for turnips, which has proved uniformly successful, has been the superphosphate of lime as recommended by Liebig. This substance will be very carefully prepared with the requisite quantity of acid. If turnips, manured only with bones or superphosphate, be removed year by year from the same soil, the ground would gradually be robbed of the constituents which the bones do not contain, and this would greatly impoverish the soil. To prevent this in instances where it is intended to remove the turnip crop, a manure is prepared containing the other constituents of the turnip ; so that by its use the land is provided with all the essentials the turnips require. Superphosphate of lime, £7 per ton ; Turnip manure, £8 per ton. From 4 cwt. to 6 cwt. may be used per acre, and either of them will insure a crop.

BEET ROOT, MANGEL WURTZEL, AND CARROTS.

These being, like the turnip, broad leaved plants will require little else than the mineral ingredients of the soil for the purpose of procuring a beautiful crop. The phosphates of lime and magnesia, with a due proportion of soda and potash, will therefore, with a small amount of ammoniacal salts, constitute the ingredients for these plants. The price will be £12 per ton ; and from 4 cwt. to 8 cwt. may be used per acre.

WHEAT, BARLEY, OATS.

Top dressings for these plants require to be used with considerable care, as there is a great liability to throw down the straw, and thus almost wholly to lose the crop. The utmost efforts will be taken to prevent the occurrence of this misfortune. Beside the proper mineral ingredients, the plants will be supplied with a source of ammonia furnished by slow decomposition of the manure in the ground, so as to supply their daily requirements, The price will be £14 per ton, and 3 cwt. or 4 cwt. may be applied per acre when the wheat has recommenced its growth. The manure may be drilled in with barley and oats, taking care to allow a sufficient amount of earth to intervene between the seed and manure, or it may be sowed broad-cast over them when a few inches out of the ground.

GUANO,

The best description only will be supplied.

Before these articles are admitted into stock, samples of the bulk will be submitted to the inspection and analysis of Mr. Nesbit, as great quantities of adulterated and damaged guano are at present in the market.

☞ The above manures will be sent out in bags of 1 cwt. and 2 cwt. each, stamped "Nesbit's Manures ;" and they will be delivered free to any railway station or wharf in London, or they may be had from the various agents.

The whole of these Manures should be first mixed with ashes or dry mould, and then drilled or sown, as circumstances may require. Manure for beans, peas, cabbage, and other vegetables, may be had on application.

LECTURE

ON THE APPLICATION OF CHEMISTRY TO AGRICULTURE, DELIVERED AT FARNHAM. BY J. C. NESBIT, F.G.S., M.C.S.L., &c.

(From the "Mark Lane Express.")

On Thursday, Dec. 17th, a gratuitous lecture was delivered at Farnham, by J. C. Nesbit, Esq., F.G.S., M.C.S.S. The large room at the Lamb and Hare was quite filled with a highly respectable audience, including all the most influential farmers of the district.

Mr. ATTFIELD said: Gentlemen, on occasions like the present, I believe it is customary to appoint a chairman. I beg to propose John Paine, Esq., to fill that office.

The motion having been assented to by the company,

The CHAIRMAN said: Gentlemen, I shall not detain you one moment; for we are all, no doubt, very anxious to hear Mr. Nesbit. I am quite sure, at least, that those who heard him last year are very anxious to hear him again. Let us, then, at once proceed to listen attentively to what he has to say.

Mr. NESBIT: Mr. Chairman and gentlemen, I assure you that it is with very great pleasure that I once more have the opportunity of appearing before you in Farnham. Having met with such a warm reception before, it is now and will always be a source of gratification to me to meet my kind friends in this part of the country. In the last lecture I had the opportunity of just opening, as it were, the subject of the chemical nature and properties of those substances which you have at work on your farms. It will be my duty this evening to extend my remarks still further into that department of science, and to point out to you, if I possibly can, the natural and proper system of manuring, by which you may best save a penny or gain a pound. You will recollect that on the last occasion I mentioned that there were a certain number of substances found on your farms, a certain number of substances found in manures, and a certain number of substances found in the crops taken from the land. On that occasion I illustrated their nature. On the present occasion I shall speak of them with far less reference to chemistry than to agriculture, and to all those principles which I shall have the pleasure of bringing before you. The substances found in the soil are generally identical with those which you see here (pointing to a diagram). There is potash, soda, lime, magnesia, iron, alumina, silicic acid, phosphoric acid, sulphuric acid, muriatic acid, and fluoric acid. Although there are in nature about sixty elementary bodies, yet not more than those which I have repeated are found in the land; so that, in reality, the chemistry of agriculture is reduced within much smaller limits than general chemistry. Now these substances are found in the land, most of them in plants, and most of them also in manures. I do not know whether the chemical names are well known to you; but, at all events, I shall, in very few words, point out what these substances are. Potash is found in saltpetre—it is the base of saltpetre; and pearlash is carbonate of potash procured from the ashes of land plants. Soda is found in common salt, which is used for making soda. Lime every one knows, both in the state of lime and in the state of carbonate of lime, which occurs in nature as chalk or limestone rock. Magnesia is the base of common Epsom salts; it is found in most lands to a certain extent. Iron is found in the land in the state of oxide or rust of iron. Alumina is the base of all clays; without alumina you cannot have a clay. Silicic acid is sand; but sand is sometimes soluble and sometimes insoluble, and if silica be found in plants, you are perfectly aware that it must have previously been in solution in water to have enabled the vegetable to take it up. Phosphoric acid is found in bones, of which it is the base; and, in small quantities, in most soils and rocks. Sulphuric acid, as oil of vitriol, is much used in the agricultural world for mixing with bones. Muriatic acid is found in common salt united with soda; the acid itself is known under the name of spirit of salt. Fluoric acid is found in such minute quantities as to be scarcely appreciable. I have detected it in Farnham hops, but in very minute proportions. I have thus re-introduced the mineral substances which are found in the soil, in the crops, and in manures. There are other substances found in vegetables, but these are provided for most plants by the air. There is charcoal. You all know what charcoal is, and that it is contained in large quantities in vegetables; that substance generally comes from the air. Nitrogen is also supposed to come generally from the air. Hydrogen and oxygen are found in water. You will remember that I said in my last lecture that the atmosphere is composed of oxygen and nitrogen, and likewise contains watery vapour and carbonic acid gas. I now come to treat of manures. Those manures which have been known from ancient times amount only to one or two. Farm-yard dung and the excrements of animals have been known for a very long period; these are the two staple manures. I shall proceed to show whence the manure from animals arises. It has been found in all countries and in all places, that when land has been manured with animal excrements, either in a liquid or solid form, great benefit has been received by the land, and good crops have been obtained; and it has been thought by many that some peculiar action must take place in the animal system by which these manures are produced, and that great benefit is gained by passing food through the bodies of animals. Now let us inquire, for a moment, where these manures could possibly come from. Animals live upon vegetables; all at least of those animals that you have upon your farms. The sheep and the oxen live on vegetable matter. Vegetables are masticated and digested, and a certain portion is then rejected as being no longer fit for the uses and purposes of the animal economy. The matter which is thus rejected by the animal is that which you find beneficial; but you do not discover in that which comes forth from the animal any additional principle; you do not see any principle different from that which entered into the animal at first. The animal has, in fact, abstracted some of these substances. You give your animals certain quantities of vegetable matter; they abstract a certain portion for their own use, and they reject the rest; and it is that which is rejected by them that you find so beneficial to the land. Now the quality of the matter rejected depends very much on the quality of the matter eaten. If you feed bullocks with straw, or chaff, or turnips, alone in one case, and with oilcake in another, you are perfectly aware that the manure in the one case is not equal to the manure in the other. The oilcake manure, if I may so speak, beats the other manure; you give these substances in different quantities and different qualities, and therefore the one manure differs from the other. If you give the animals chaff and turnips alone, the manure is deficient in those things which are required for growing the seeds of the crops. Grains absorb and take from plants the greatest amount of substances. The purpose of the life of a plant is to reproduce its kind, and therefore the ear will exhaust every other portion of the plant in order that the seed may be re-produced, and another generation be given. It is for this reason that when you give oilcake, which is crushed seed, to your animals, that which is rejected is richer manure for seeds or grain than the manure furnished merely by chopped straw, hay, or turnips; it is richer because those substances which are thus given out by the animal from having eaten the seeds of vegetables are calculated to reproduce the seeds of vegetables, while that which is rejected by the animal when it has eaten merely hay or straw is calculated merely to reproduce hay or straw. I do not know whether I am perfectly understood in this, but I will repeat, in substance, what I have just said. The whole of the manure which comes from the animal is derived from the vegetables on which it feeds; and if these vegetables are exceedingly rich in certain kinds of things, speaking relatively, you may call the manures rich, because they produce a certain kind of crop which sells for the greatest price in the market. Every one knows, however, that hay and straw will produce more hay and straw than oil-cake alone; because the substance which comes from oil-cake is calculated to give straw too great vigour and too little strength, so that it will not stand well in the ground. You may, in fact, by having too strong manures of a certain kind, throw straw down, instead of giving it strength to stand up. Then the quality of the manure which an animal produces depends altogether on the quality of the vegetable food which you give it. If you feed an animal merely on hay and turnips, the manure will give far less vegetable matter in the succeeding crops than if you feed it on chopped straw, beans, oats, barley, oil-cake, or linseed. These latter are the most valuable substances in the market; and the manure obtained from them is also the most valuable manure. Take the action of the animal system of a full-grown bullock. If a bullock be full-grown, it takes a certain portion of the fatty matters of the food which it eats: those fatty matters go to reproduce fat on its own body; and by the experiments of Liebig it has been shown that a portion of the sugar and starch is also changed into fat, so as to be deposited in the animal system. A certain portion, also, of what is called fibrine—a vegetable albumen, a certain portion of that which you find in wheat-flour, which when you wash it in your hand, it leaves there a sticky matter—enters into a full-grown bullock to form its flesh; and all the mineral ingredients which are derived from the land, and which do not enter into the fat of the bullock, and only slightly into the flesh, go back again to the land: so that you have no loss of mineral matter in the case of a full-grown bullock. If you carefully collect the urine and other ingredients, you have merely the loss of a certain amount of the organic matters of the plants, which they chiefly derived from the air. In using these manures, therefore, for fattening your animals, you obtain a much greater amount of fat and flesh; you have a much better manure than you would otherwise have, because you have a quantity of mineral and vegetable matter which you add to the land in the excrements of these animals. Well, then, all the full-grown animal does is to absorb a small portion of the food, and leave the rest fit for growing vegetables. If you have a growing stock, or animals giving milk, the case is different. Those who know anything at all about cows yielding milk must be aware that the manure given by these animals is not so good as that which is given, from the same quantity of food, by animals that are not giving milk. If you feed young stock, they will not only take a larger portion of the vegetable matter which the plant has derived from the air, but they will also take a much larger proportion of the bone, earth, and other mineral matters contained in the vegetable matter. They must have these while they are growing, and they therefore seize a larger portion of the vegetable constituents of their food than stock which has attained a certain height. And as the cow has to supply to her young a certain amount of substances perfectly available for the growth of the animal's body, for its bones, flesh, and fat, so its excrements must be deficient to a larger extent in these substances than the excrements of an animal which has not to afford the same supply; so that the effect as regards the manure of the two animals will be quite different. I may mention a singular instance which occurred near Maidstone. A gentleman applied some guano to his hops with the very best result; he obtained a great increase in his hops by the application of about five cwt. His next neighbour bought some of the very same kind of guano, and applied it to his hops, and with no result. The farms adjoined each other; the land was the same in quality; yet, while in the one case the guano did every thing that was wanting, in the other it did nothing at all. I was lecturing at Maidstone soon after, and I had this question put to me by the gentleman who had been successful: "How is this, Mr. Nesbit? I bought some guano, and put it on ten acres of my hop ground, and got a very good result. I supplied my neighbour with some guano from the same bulk, and this was put on hops on land of the same quality, and yet obtained no result at all?" The first thing I said to him was, "Did he manure properly?" "We manured," was the reply, "in pretty nearly the same manner." "How?" I said. "By means of fatted dung," he replied. Well, it seemed quite inexplicable. "But," I said, "what kind of beasts do you keep?" "Oh," he said, "I keep cows." "And what," said I, "does your neighbour do?" "Why, he fats bullocks," was the answer. Everything was explained at once. I happened to have suspended from the wall two diagrams containing an analysis of guano, and an analysis of milk, and these immediately showed that everything contained in the milk of the cows could be supplied also by the guano. The gentleman who had the cows on his farm had exported all these valuable ingredients (pointing to the diagram), phosphate of lime, potash, soda, nitrogen contained in the form of gluten, in the milk. But his next neighbour, who fed his bullocks in a similar manner with oilcake, had such a quantity of these materials put into the ground by the manure of his stock, that the guano produced no effect at all. So that you see the manure varies, not only with the quality of the substances supplied for food, but also with the nature and state of the animals employed in eating. Now, gentlemen, having thus stated—I hope clearly, and if not, I shall be happy to answer any questions that you may think proper to put to me at the close of the lecture—having thus stated what is the nature of the food of animals, I shall proceed to describe the nature of farm-yard dung. But, before I do this, allow me to remark that you cannot have more manure given out by animals than is previously contained in the vegetables on which they feed; that is to say, if you feed a flock of sheep with turnips, you have not more manure than you would have had if you had ploughed the turnips in and caused them to rot in the land; and I believe that by the rotting of the turnips in the land, you would have more manure than by feeding the sheep with them, because the sheep as they were growing would take something away for their bones and flesh; it is clear that they must take something during the period of feeding. If you add oilcake, you certainly get the benefit of it in the manure as well as in the fat and flesh of the animals. I am not speaking in a pecuniary point of view at present; I am not saying whether it is better to plough turnips in or to feed them off: I am merely telling you now that when you do feed off, you merely make use of the sheep to eat the turnips off, and I say that more manure woul necessarily be obtained if you had caused the turnips to rot in the land. So also with every other manure. You know that such is the nature of green crops, that you often find it more expedient and profitable to allow green crops to be ploughed in than to allow them to pass through the bodies of animals in order to undergo decomposition. Now farm-yard dung consists of animal excrements, together with vegetable matter; the vegetable matter is of course derived from the soil and from the air. The way in which you make manure from vegetable matter is to allow it to rot, or to putrefy, or to ferment, with animal excrements. You allow a certain amount of heat to take place, taking care that there is not too much. The sweepings of the straw, the straw which has been under the cattle, and the rejected food of every description, are allowed to mix together and to ferment. A considerable decrease of bulk takes place, a certain heat is given out, and the result is that you get the whole of these vegetable fibres and tissues half-rotted, and capable of being cut with a spade. The bulk of the manure, however, evidently decreases; there is not so much bulk after the lapse of six or eight months as there was at the first. Now a certain action has taken place there. You have had the oxygen of the air always present—the vital principle of the air, that which consumes the coals of a fire or the fat of a candle, you have had in the manure, consuming certain portions of it, and leaving the rest in a state in which it could easily be washed away, easily be made soluble for the use of plants. The oxygen has taken a considerable portion of the charcoal, and you know that in uniting with charcoal heat is given off, whether it unite quickly as in the smith's forge, or slowly as in the case of an ordinary fire, or yet more slowly as in the case of the manure heap. Yet we all know that if care be not taken, a heap of manure will fire and spoil. Now if you take care that through the washing of the rain you have not a loss of any of those substances which are found in the ashes of plants, not one of the constituents will be lost by the mere moisture; all that you can lose is a certain portion of charcoal which goes off in the form of carbonic acid, and a certain portion of hydrogen which goes off in the form of water. I do not say that this is not a loss, and that if you could cause this to act in the ground you would not be benefited; but in general cases no benefit is to be obtained from putting fresh dung, except on heavy clay lands, where mechanical action may be useful to lighten the soil. It is better to allow a certain amount of decomposition to take place in the manure heaps which lie in our yards. This decomposition will take away nothing from the manure heaps but the charcoal and the hydrogen, if proper care be taken. There is a chance, indeed, of one very valuable ingredient escaping—very valuable for some crops, of little use for others—viz., ammonia. Nitrogen is the base of ammonia, and this is valuable for some crops, though in the case of others its value is not so apparent. This, at all events, ought always to be kept, if possible, in the farmer's dung. Under ordinary circumstances much ammonia is lost from the farmer's mixen by fluctuations of heat and exposure to air. The sprinkling of gypsum upon manure heaps, and the keeping them not too light, will entirely remedy that evil. Well, we have seen that the action which takes place upon vegetable matter and upon animal matter is the same. The vegetable matter which passes through the bodies of animals, goes through just the same process, only in a different way, as that which is decomposed in the air. A certain portion is taken away in the animal system; the animal takes it away partly in the body, and partly breathes it out by respiration. When vegetables are decomposed by the action of the air, a certain portion, instead of going to the body of the animal, is taken into the air. But there is the same result. We see that the whole of the manure comes from vegetables; the whole of the manure which is given by animals, and which you have in farm-yards, comes from the vegetable kingdom. That which you have taken from the vegetable kingdom is received back again. But now where do the vegetables themselves get this from? We know that they contain potash, soda, lime, magnesia, oxygen, nitrogen, charcoal, &c. Where do they get them? We find, by analysis, that many of these substances come from the land: the vegetables get silica, magnesia, lime, potash, soda, iron, phosphoric acid, &c., from the land; they also get oxygen and hydrogen from water; and the great source of all the charcoal and the ammonia is the air. I will not say that all plants have like facilities for deriving their ammonia and vegetable matter from the air; but I will show you instances in which plants do derive all their vegetable matter from the air. It is well known that the lavas of Vesuvius, thrown up red-hot in a melted state by an eruption, when they have got sufficiently cool will produce, by the disentegration of the atmosphere, a soil in which the wild fig, and other plants, grow most luxuriantly. In one of the Cape Verde Islands there is a vast quantity of lava; and this lava is powdered and used in that state, and is a most effectual manure. We know, too, that pine trees are capable of growing where no vegetable matter has been afforded except a few lichens or mosses, such as we see growing on our old walls. If you take an acorn, and put it in the ground, it will grow and increase till at last it is become a large oak, containing thousands of pounds of charcoal, and yet the ground around the tree shall be richer in carbon than before. It could not have derived this charcoal from the ground, because it contains at least more than it had before. The oak has derived its carbon from the air; and the nitrogen and the hydrogen which it contains have also been derived from the same source. Now the fact is, that while the sun shines on the leaves of these plants, they have the power of absorbing the charcoal from the carbonic acid of the air. Carbonic acid is composed of carbon and oxygen. One part in two thousand of the air is carbonic acid. It is only when the sun shines on vegetables, or in the diffused light of day, that plants have the power of decomposing the carbonic acid of the air, retaining the charcoal and liberating the oxygen. That they have this power is a well-known fact, attested by experiments which have been tried again and again. Boussingault put a branch of a vine into a glass tube while the plant was growing; and through this tube was sent a current of air, containing a certain per-centage of carbonic acid. Carbonic acid, you know, is easily detected by the white sediment it produces in lime-water. When the gas was passed through the tube while the sun shone brightly on the branch of the vine inclosed therein, not a particle of carbonic acid issued therefrom. This was proved, by passing the issuing gas through lime-water, which gave no precipitate. As long as the sun shone upon it, not a particle escaped decomposition; the carbon was wholly retained, and the oxygen given out. The experiment has been tried in various other ways. It is now pretty certain that plants generally derive their carbon from the air. Take any soil whatever; take land after a clover crop, you will find that it contains more carbon after you have cut the clover than it did before the clover was sown. A forest in Scotland, which was planted fifty years since, now contains more charcoal than it did at the commencement of that period. Nitrogen, in the form of ammonia, is also derived from the air to a great extent, being brought down by means of rain. It has been detected in rain-water when sought for, and likewise in snow, and is thus known to exist in the air. Whether all plants derive all the nitrogen they want from the ammonia of the air, is another question. It is not a well-settled point, and we want the experiments of you agricultural gentlemen to decide it. It is ascertained that such broad-leaved plants as turnips, clover, and others of a similar kind, absorb a great quantity of the ammonia of the air; but whether such plants as wheat and barley can derive all they require from the same source, remains to be decided by well-directed experiments. Now, I think we have seen, gentlemen, pretty clearly, that the whole of the manures which you put on the earth under the name of farm-yard dung, came originally from the earth, and from plants grown in the earth. It appears, therefore, that there is nothing extraordinary—no virtue inherent in farm-yard dung which should cause it to be the only manure made use of; but that if you can find other substances similar in composition to farm-yard dung—if such other manures are to be obtained in the market of the world at a less expence than farm-yard dung, it is your duty, as men of business, to look out for those other manures. Having spoken to you thus far on the subject of manures, I now want for a few moments to point out to you the losses you are subject to every year, from the waste of manure, and the way in which they occur. The reason is, that except under certain circumstances, in order to farm well, you are obliged to supply to the soil more manure than you can get from the refuse of the farm. Lest you should think that I am speaking of more than you can carry away on one occasion, let me inform you that this lecture will be published in a newspaper, when it may be read by you at leisure. Therefore it is that I go so fully into the matter; and as I think the last lecture was attended with some practical benefit, I hope the present one will be attended with ten times more. I therefore proceed to speak of the losses to which you are subject on your land. Supposing you do not import manure on your land, you are subject to losses by everything that you export from the land. You export, for example, wheat and barley, &c., and retain the hay, straw, and oats; you are subject to the loss of every mineral ingredient that you export in wheat, which contains a large quantity of phosphoric acid and ammonia; you are subject to a similar loss in the case of the barley; you are subject to the loss of all that is exported in the growing stock; in every shape in which you export from the land you suffer a loss, that is to say, the farm will become less rich, particularly in mineral ingredients and ammonia, than it was before. You also suffer a loss by the action of the water, which descends from the heavens upon your land. This water has the property of dissolving all the most valuable substances of the soil; if it had not that property, the plants could not take up these substances from the soil. It has that property, however; and plants do avail themselves of it by taking up water containing soluble matter. The water does not take up large quantities at a time, and a great portion; out great quantities of them pass to the roots of the plants to give them nourishment, particularly in summer. In winter, however, and particularly in drained land, large quantities of soluble substances pass out of the land every year, because of the action of the water which falls on them from above. If you suppose every pint of rain water to dissolve only one grain, it will appear that the loss of one grain per pint for the rain of a year gives a loss of 840 lbs. weight of soluble matter per annum. Well, then, you are subject to this loss; and it is a loss which is quite unavoidable, for without the action of water you could never grow any plants at all. You might have the same substances in an insoluble form, and you could not get anything to grow. Change the nature of those substances by any action which you can bring to bear upon them, so as to render them soluble, and you at once get a soil capable of affording life to plants. Now, gentlemen, there are very few farms in the kingdom on which you could repair these losses without importing manure. There are some exceptions, and I will mention them. The first case is that in which there is attached to the farm a portion of marsh land. You may, by means of this marsh land, receive in filtrations from the sea, or from a river, manure which will give sustenance to vegetables. You may have such a yearly quantity of hay grown upon these marsh lands as will provide everything that is requisite to supply the annual loss of the arable part of the farm. It is, however, only in certain localities that this can take place. In another case, you may have running or irrigated meadows, where the water which has passed over other people's land, and received many valuable substances in its course, is allowed to float over yours. By such means you can do without buying manures; you can find enough of manure in the meadow part of the land to supply the loss caused by exporting the products of the arable land. I have been told by some gentlemen of another case, where some farmers export nothing but wheat, and, feeding all the barley and oats on the farm, never buy anything in the shape of manure. I have said to these gentlemen, "I don't doubt in the least that you may make this answer for many years—that is, export all your wheat, while you consume all your barley; for this is no great thing to do for twenty or thirty years. But," I have added, "you will not do that for ever; you will not do it for a continuous series of years; every year the farm will get less and less valuable with respect to all these ingredients; you may obtain more and more of these ingredients from the air; you may obtain more carbon and ammonia; but these will only assist in the exportation of the mineral substances, in aiding their solubility, and in sending them away; and it is impossible that they can be thus constantly exported without eventually bringing sterility. "Always taking out of the meal-tub and never putting in, soon comes to the bottom," as poor Richard says. There are, however, many persons who suppose that they can make all the manures they require on their own farms. To shew that this is not the case, however, I may instance the splendid tobacco lands of Virginia, where tobacco and wheat were exported for a long period. These lands, and other new soils, were first known by the name of virgin lands, as if there were something peculiar in them, whereas in fact they contained a greater quantity of mineral substances than other lands long in cultivation. Wheat and tobacco were exported in great quantities from those lands, and for a long time they were considered incapable of exhaustion; but in 150 years they were actually exhausted. Now they cannot grow anything without the application of manure containing those very substances which had been exported from them in the shape of wheat and tobacco. I will mention another case, the case of the sugar plantations. I happened to be coming from Paris a few months since, when I had for a companion the owner of some sugar plantations in British Guiana and Trinidad. He told me that they could not grow sugar now as they did formerly; that they were obliged to look out for manures. He asked me a great many questions, and I gave him a little information on the subject. I recommended him to use the ashes of the sugar-cane (which are there thrown away) as the best thing that he could have for this purpose. He said it never struck him before, but he would write over at once, and it should be done. A gentleman has lately written over to ask what these ashes contain. They were found by an experienced chemist to contain abundance of phosphoric acid, potash, lime, and soda; and the analysis bore out what I have stated. Another friend of mine has visited Cuba, and what does he tell me? He says the practice there is to go and settle down on a certain portion of virgin land, and to export all the sugar they can without manure for ten, twelve, twenty, or thirty years; and then, when you cannot get any more from the exhausted soil, to break up the establishment and to go still further into the interior; when the exports from the land have taken away a certain portion of the mineral and other substances, it is found necessary to remove to another quarter; and so they proceed in their course, exhausting successive portions of land, leaving behind them the same devastating traces as are left by the passage of an army which has destroyed and ravaged every thing in its course. The land is left without the power of growing anything at all, an uncultivated waste: this I had from an eye-witness. Well, now, when you cannot supply the necessary manures from your own farm, you must import them; and it will be necessary to speak of the manner of importing manures upon the farm. Manures can be imported upon the farm in various ways. The most general way of importing manures upon the farm, at least near London and other large cities, is by buying the excrements of animals, whether they be of the human kind or of other kinds, which have been deposited in large towns, and those things which have sallied out from your premises, you buy it to return back again. The food consumed by animals and by the human race is collected, though not to the extent that it ought to be, and brought back again to the land; this you pay for—and you derive from it great benefit. Now, there is what is called the London dung. It is always to be had; and it is, no doubt, an excellent manure. If *genuine*, it must contain all that is left from the eating of the wheat, which is the most valuable of grains, and consequently that which is left from it is one of the most valuable manures. It must contain phosphate of potash and soda, together with phosphate of lime and magnesia, and it might be beneficially mixed with other substances. This London dung also contains the excrements of animals, such as horses and cows, which have been fed on turnips, straw, chaff, and hay; all these substances will be exceedingly beneficial to the farmer.

I will now go briefly through the manures which are found most beneficial, and it must then be left to you, gentlemen, to see which of these substances, at the money price, would be most beneficial to your farm. Many persons, whose farms are near the sea, import fish on their land. These fish contain abundance of phosphate of lime and magnesia (bone dust), a very important ingredient; and they contain ammonia, carbon, a little salt, and potash. They are what is called a quick manure; that is, they act quickly; but if you put them year by year by themselves, without applying something more solid, they would not continue to produce a good effect. When those who are near the sea use fish, I would advise them to mix them with other manures, to prevent their quick action from deteriorating the value of the land, by taking more from it in the year than it is capable of affording without injury. There is another most general means of introducing manure on land, though it is not generally known as such, viz., by feeding cattle with oil-cake. This is not generally regarded in that light; but still, it is neither more nor less than a means of manuring land. The oil-cake being composed of linseed which has been pressed from the oil, still contains considerable quantities of carbon and hydrogen, which are derived from the air, and of nitrogen, and forms a very good food for animals; they can derive from it a large quantity of fat, and some flesh; and that which is given out from them as manure contains large quantities of the mineral ingredients, together with a very considerable amount of ammonia. Well, the mineral ingredients and ammonia thus furnished by the oil-cake, is one way of manuring the farm. Oil-cake is very expensive, and it would not pay to feed cattle on it—at least, so many farmers have told me—were it not for the manure They feed the animals because the manure which they get is so valuable. They tell me, "We sometimes lose £100 or £150 a year by our bullocks;" "but we must feed bullocks," they add, "because we thus manure our crops." When I was lecturing at Maidenhead, and had occasion to speak on this subject, I had to disabuse the minds of certain gentlemen as to the absolute necessity of submitting to a loss for this purpose; whether I was right or wrong you will be able to judge. A gentleman told me last spring, when you will recollect there was a great deal more turnips than the sheep would feed off, at least in that part of the country, that he would give any one £2 an acre to send a flock of sheep to feed off his turnips. It struck me that this was too much; and I said to him, "Do you expect to derive anything from their feeding on the turnips?" He said, "Certainly." I rejoined, "In my opinion the sheep can give you nothing but what the turnips contain; the turnips will only pass through the bodies of the sheep. Do you not think that £2 spent for guano, with the turnips ploughed in, would give you more manure than £2 paid to feed off sheep?" I had a strong argument to maintain in the presence of a great number of gentlemen. The gentleman, of whom I have spoken, said, "If you will come to me to-morrow morning, at my farm, I will convince you." I replied, "I will be with you." I went over the farm in six hours; and that day I gained two converts, the gentleman and his son; and I believe they are now two of the first agriculturists in the neighbourhood. I had time to explain my views to them, and they soon saw that if you could get the turnips to rot in the ground, and were then to apply £2 worth of guano, you would get very much more than you could obtain by feeding off a certain number of sheep merely on the turnips. Well, then, I say that under certain circumstances it may be profitable to you, instead of feeding sheep, to use a certain amount of guano and other matters which may be put on the land, or to plough in your crops. It is a money question entirely; if we can obtain what we want for a pound less in one way than in another, it is necessary, in a commercial point of view, to get that which will cost the least. I do not call upon you to go and try a whole farm full of experiments of this kind; but the next time you are placed in the position which I have described, try an acre or two; and if you find, subsequently, that the crops are as good or better, you will have lost nothing by the experiment, and you will be enabled from your own experience, when placed in similar circumstances again, to do without the advice of a chemist. You see, in fact, with reference to the oil-cake, that the farmer imports the produce of one farm to put on another. Now there is another valuable manure which is well known, though it has only been recently imported. This manure, like all other manures, is derived from the vegetable world. Our rivers are pouring down, year by year, from the surface of the land, bone-dust and potash and soda and ammonia, and a thousand things besides, into the ocean. All the soluble matters of the earth's surface are poured down by the rivers and rivulets into the sea; not, gentlemen, to exist there for no purpose at all. As large and extended a vegetable kingdom exists under the surface of the waters as above them, and the source of animal life in the sea is the same as that which sustains it on land. The fishes feed and browse on the sea-weed, as we call it, and on other plants belonging to the vegetable kingdom in the ocean. The carnivora of the fish kind feed on these fishes, as the fish feed on vegetables; and the birds of the air, having fed on fishes fed on the vegetable kingdom of the sea, deposit their food in places to which they resort. Now, the excrements of these birds—the birds themselves having fed on fish, which contain large quantities of every element of manure—must afford valuable ingredients. We have immense quantities of these excrements annually deposited all round our own islands, and wherever it can be collected, it is a most valuable manure; but in this country the rain falls in such abundance as to wash away, in the winter, nearly all that is deposited by these sea birds in the dry weather. There are localities, in the earth however, where the rain falls so seldom, or in such small quantities, that it acts scarcely at all upon these excrements, and they go on accumulating till they grow up to many feet in thickness, particularly in those islands which are scarcely ever visited by man, whither the birds resort in immense numbers. Well, now, the excrements of these birds being thus collected in a dry latitude, and consolidated for many years, until they almost have the appearance of a rock, contain almost every essential ingredient for the farm, though not, perhaps, precisely in the proper quantities. They contain large quantities of ammonia. Ichaboe guano contains from eight to ten per cent.: Peruvian guano, ten, twelve, fourteen, and even sixteen per cent.; it contains, besides, phosphoric acid, lime, magnesia, potash, soda—the two latter in the same quantities, not more than two-and-a-half, or at the greatest, four per cent. Now, as a stimulating manure, guano is a very good thing to apply to land. In all cases where land is heavy, and not apt to germinate as it ought to do, an application of guano will stimulate it to a very considerable extent, and cause the plant to germinate and rise quickly. But if you do not supply the plants with that of which the guano is deficient, for their increased growth, it will, in the long run, do more harm than good. The guano contains the chief acting part of ammonia and bone-dust; but if you do not supply the others, and if the land is not capable of supplying them, you may obtain a bad result from the application of guano. It is a well-known fact that the continued application of guano is attended with bad results. In the vicinities of the parts from which guano comes, near Peru, there are places which become perfectly sterile from its use; but some of these places have been made fertile again by the application of nitrate of soda; and at the present moment there is an exchange going forward of guano for nitrate of soda in the countries which produce these substances. There are certain places in South America where nitrate of soda is found, as we find an efflorescence on the walls of new buildings. Guano is exported from one place, and nitrate of soda from another, and we find the exchange acting in the most beneficial manner. Where guano has been acting, the application of nitrate of soda is found to supply some portion of what is wanted. Guano may be considered as a sort of representative of animal manure. Again, greaves and rags, and all such things, form an exceedingly good manure. These contain large quantities of nitrogen, and are capable, by their decomposition, of giving large quantities of ammonia. They are exceedingly good for those plants which require these substances, such as wheat and hops, upon both of which they are known to produce the best effects. But the application of these alone will bring about a sterility of the soil, which is not desired by the farmer, who wishes to gain year by year, and not one year alone. Now, rags and other things containing large quantities of ammonia are very useful where mineral ingredients have been supplied to a certain extent. I have analyzed the mineral ingredients of the rag ashes, and I found that they contain 10 per cent. of mineral matter, and in that 10 per cent. is a large quantity of bone-dust. The furnishing of ammonia to the soil constitutes, perhaps, one of the principal features of these manures. Now, as I before intimated, we may reckon all the animal manures—such as shoddy, horns, hoofs, trotters, rags, &c.—as acting similarly to guano. The only difference is, that the guano acts more quickly, because the ammonia is in a far more soluble state, and is capable of being carried into the soil by the first shower of rain. Now there are other manures besides these; there is bone-dust or phosphate of lime. How is it that bone-dust has been found such a splendid manure? Bones have been used in almost all quarters with almost unqualified results; there are very few places in this empire where they have not been found useful. I have heard of their not having been very useful on the Malm rocks (upper green sand); I have heard of two or three cases in which they have been found of no service there; but, at all events, on general soils the bone-dust has been found of great use. It is easy to account for this. I have mentioned to you the action of the rain, which is such that, supposing one pint of water to dissolve a grain per acre, 840lbs. per acre are washed away every year. But you will recollect that, in addition to this, until very lately the plants were taking bone-dust constantly from the ground, and thus providing the material for the bones of animals, without any restitution being made to the land. As for man, all his bones are, according to custom, deposited in certain places, and never return to the land; and, until recently, the bones even of the other animals were never restored to the soil. The consequence was, that soils generally became impoverished in bone-dust. Bones consist of certain kinds of animal matter called "gelatine" and "fat," and of a portion of mineral matter called "phosphate of lime and magnesia." It is a very singular thing that bones deprived of the animal matter act more quickly than fresh bones. The fact is, if you take some bones and bruise them fine, and then take others and burn them, the latter acts quicker than the other. The fat of bones prevents atmospheric action on them; and you know perfectly well that unless they are soluble they are of no use. They are of no avail to the farmer if they are not soluble, and the more soluble they are the better. The burnt bones are, therefore, acted upon much more quickly than the others, though we have a loss of the animal matter. It is to Liebig that we owe the suggestion of making bones much more soluble than even burnt bones. The main fact had been long known. The common method of making phosphoric acid formerly was to take a certain quantity of burnt bones, and to mix them with a certain quantity of oil of vitriol, by which means the phosphoric acid of the bones was set at liberty. The bones consist of phosphoric acid and lime, with a little magnesia; the sulphuric acid siezes upon the lime, and forms sulphate of lime, or gypsum, and liberates the phosphoric acid. Phosphoric acid is quite soluble, as soluble as sugar.

Now that is just the thing which the mind of Liebig applied at once to land. "If," said he, "we can just do the same thing for the land, the first shower of rain will wash this phosphoric acid down the land; it will there meet with lime, magnesia, and other things, and form phosphate of lime and magnesia, but in a state of the most minute division, so that it will be acted upon by the smallest quantity of water. Now, without any exception that I am aware of, where bones and sulphuric acid have been tried, it has been found beneficial for the turnip crop. Turnips have been obtained in abundance by the application of this manure; I have never yet heard of a failure. In almost all soils there is lime, so that the phosphoric acid will find something to neutralize it, and cannot injure the plant. Turnips find the bone-dust prepared for them in the minutest state of division. This manure is also suitable to other root crops. In a general way, you export no turnips from the land; you would take more from the farm land were you to export the turnips year by year. In the latter case, you would take away such a large amount of potash and soda, and other things which the turnips require, and which the bones do not give, that I think you would find it very difficult to grow them year after year without a very considerable application of other manure. That question may be settled very easily ; but in the case of the ordinary turnip crop, it seems pretty well ascertained that if you apply phosphate of lime, you can grow the turnip ; and every one knows that if you can grow the turnip you can get the three subsequent crops. Now, with respect to lime, that is an excellent manure. In the analysis which I made of the hop, I found lime, more particularly in the coarser hops. In all cases, I find that lime has done good to the hops, but great care ought to be taken in applying it. I have known parties apply it in a way which was certain to do mischief ; they have applied it with manure ; and when lime is applied with manure, it must drive off all the ammonia contained in it. I have here samples off manures containing ammonia ; there is some beautiful Peruvian guano (exhibiting a small glass bottle containing the substance). I will just show you the effect of mixing lime with this. A friend of mine in Kent, who had found lime good for his hops, having heard that guano was a good manure, mixed the two together, and thus drove out all the ammonia. My opinion is that the best plan is to apply the lime first to the land, and the manure afterwards, so as to let the lime become what is called mild by the action of the air, and after that to apply the manure. This is a specimen of beautiful guano (handing the bottle to the company) ; you will find no great amount of smell. Now I will take a little lime. There is scarcely any smell, because this lime (exhibiting it) is perfectly dry ; and if the guano had been dry, there would have been no smell whatever. Now I will just put a small quantity of water, in order to cause this lime to become slack, for it acts in that state and not in the other. (The lecturer here added the water, and, on mixing the whole together, a strong smell of ammonia was produced.) I may here remind you, gentlemen, that in buying guano you should remember that that which smells the strongest is not the best; the smell merely shows that the ammonia is escaping very quickly. The best Peruvian guano, that which is the driest, has scarcely any smell at all. Now, lime has also an action on the mineral ingredients of the soil, for it liberates the potash and the soda, which are generally in the ground in an insoluble state in union with silica, and the lime which is brought into contact with the silicates has the property of liberating the potash and soda. So that the lime acts in two ways ; it acts on the ammoniacal and carbonaceous matters, but it acts more particularly in decomposing the silicates of potash and soda. It is astonishing how soon after an application of lime it will be washed away by the action of air and water, and how soon it will again be necessary to apply it. Now, gypsum, again, is only another application of lime. Gypsum is a sulphate of lime. Every 77 parts of gypsum contain 28 of lime and 49 of sulphuric acid ; so that in applying gypsum to land you supply lime also, and in a state in which it can be easily taken up by plants. Potash and soda have also been applied as manures, and, where the land has been deficient, with the very best results. Potash has been applied in the state of saltpetre, and also in the state of woodash or pearlash, with good results. It has been applied in the state of silicate of potash, and in one case, 1½ cwt. of silicate of potash being contrasted with other applications, the silicate of potash grew 15 tons of potatoes, while the average of the others was only 10. Soda has been applied as nitrate of soda ; but for a series of years, in consequence of containing only one substance instead of a number, it would not be applicable. Saltpetre, also, has been applied with other minerals with great success in some instances ; but the continued application of saltpetre, or of any other manure containing only one or two ingredients, is wholly inadmissible, as they do not furnish all that a plant requires, and, consequently, must tend eventually to impoverish the soil. Now, having thus spoken of each of the substances which are applied as manures—if I have omitted any I shall be happy to be reminded of it at the close of the lecture—I want just to give you the proper means of manuring. Gentlemen, your farm-yard dung contains all that is taken from your land ; it is the staple manure ; it contains all that is required, and there is not the least doubt that you can always obtain a crop with it. But the question is—What manures, in case of a deficiency of farm-yard dung, shall you use for your land ? Some will say guano, some lime, some dung, some potash or soda; some one thing, some another. Let me tell you, that whether you do it year by year, or all at once, you must put on all these ingredients. There is not one of these ingredients but what the plants want, and they cannot grow without them. It is well known, however, that you can find potash replaced by the soda. If there is not enough potash, but enough soda, the plant will take the soda and grow with it, and so also with magnesia and lime ; but there must be one or the other. So that if you were to attempt to supply, as a general system of agriculture, only one manure, keeping the rest apart, you would find that you could not farm at all. What I want to point out to-night (though I am afraid I have already kept you too long) is this, that at times it will be necessary to import on your land artificial manure. I wish to impress on your mind the necessity of putting every ingredient the plant requires ; that if you want your wheat crop to grow, you must not put one substance only, such as guano, on the land—a substance which contains, besides ammonia, bone-dust, and a very little potash and soda—which would take away from the land instead of putting into it, and in a few years would leave it in a worse condition as regards cultivation than it was in before ; but the proper system is, while you take away from your land, to return something which will leave it, if possible, as rich as before, and this can only be done by replacing on the ground that which you have taken out of it. Since I last appeared before you, I undertook an analysis of the hop plant, with which Mr. Paine furnished me, and I have stated the whole of the mineral ingredients which are taken by it from the soil. I have also published a little pamphlet of the analysis, and I suggested certain manures, with a view to the replacing not merely of one of these ingredients, but the whole of them. I reckoned up the expense of supplying farm-yard dung and hay and straw ; and I found that you could get the manures for the hop best by buying them as they come from the laboratory of the chemist. I therefore thought it would be well to publish my thoughts for the use of the farmer, saying to him in effect : " I think you will find it cheaper to buy these articles than to obtain them as you have hitherto done." I subsequently analyzed some Kent hops ; and the results, which were very much the same as in the first case, were published in the *Journal of the Royal Agricultural Society*. Now, many gentlemen in the room have tried this manure with their hops, and I believe they will be able to tell you the result. Mr. Attfield applied some of it upon three acres at an expense of 3*l*. 10*s*. per acre ; and he obtained 435 bushels of hops more than he did from the same land with 20 loads of farm-yard dung at a cost of 12*l*. per acre. That is open for trial by any one who likes to test it. I believe there are three or four other gentlemen in the room who have tried this manure with good results. I believe Mr. Paine has tried one of the manures which I recommended; with what result he will tell you. He tried pearl-ashes and wood-ashes, and found that up to a certain date those spots upon which he put this manure outstripped the others. Last week I heard of another case. When I published the pamphlet, some party in London made the manure as recommended, and sent it down to Sussex. A party who had sold five tons told me, last week, that it had been tried down at Heathfield, and had grown a great deal more. He did not state the quantity, but he said that the person who applied it had sent for him down on purpose to see it. Now, the main point connected with the truth or non-truth of what I have been saying is this, the necessity of using not one manure only, but a mixture of manures. What I want you to do is to supply to the plant each year what it will take out; not to supply a great excess of one thing and perhaps only half of the others, but to let the plant have a portion equivalent to that which it takes out of the land; for it is very certain that plants differ greatly in the amount and quality of the manure which they require. Now these experiments have been tried by some, and I hope they will also be tried by others. With respect to the wood-ashes used by Mr. Paine, I may state that I made some analyses of the wood-ashes and peat-ashes obtained near Farnham, and I shall be happy to give any gentleman the result. In mentioning the wood-ashes, I may state that they contain 29 per cent. of lime, and more than 4½ per cent. of phosphoric acid; so that they would contain perhaps 11 per cent. of bone-dust. Now a great deal has been said about ammonia, and a great many persons have tried experiments with it. I find that it very much aids and assists bone-dust. The seed of the hop-plant contains far more phosphate of lime than that of any other part of the plant. I took a certain quantity of earth, and boiled it many times until nothing further dissolved, and then with an aqueous solution of sulphate of ammonia, in which I subsequently easily detected phosphoric acid. I have no doubt that the action of ammonia is two-fold; that it helps to dissolve the phosphate of lime in order to give it to the plant, and also that there are some plants which do not and cannot derive from the air all the ammonia that they want. Under general circumstances broad-leaved plants derive all the ammonia that they want from the air; but whether in the unnatural state of affairs in which we cultivate (I call it an unnatural state of affairs because we want five times as great a crop as the plants naturally give), whether nature will furnish as much as they want, must be determined by experiment. I really see grounds for believing that for some plants, particularly those which have not very large leaves, such as wheat, it is requisite, in order to obtain the desired crops, to supply ammonia; but at the same time to furnish them also with the mineral ingredients that may be necessary for their growth. I believe that to be the true system of manuring, and I think that a bad result will follow from the action of strong ammoniacal manures alone. Liebig mentions an instance in which a party grew grapes for making wine. This person obtained large quantities of animal manure from the neighbouring towns, and he obtained great results; but in two or three years he could not get any result. He had robbed his land of all the other mineral ingredients, and he could not afterwards get it to grow anything; whereas, in another instance, a man got the very best continued results merely by manuring his vines with the cuttings that came from them. I have always advised hop growers to put back their leaves and vines in order to take the least possible amount of substances from the soil; and after that, I have recommended them to replace in the soil every substance which they have taken out of it, either in the shape of farm-yard dung or in some other shape. In the same way I advise you not to use the same dung every year, but to use dung of a different kind. Until chemistry has arrived at a more advanced state than it has reached yet, what you have to do is to take care that if you take away an excess one year you make it up the next, so as to lose nothing on the whole. I am very much obliged to you, gentlemen, for the patience with which you have heard the imperfect address that I have delivered to you; and all I can say, in conclusion, is, that if I have given you only one idea towards the proper cultivation of the soil, I shall be exceedingly happy that such has been the result. If any gentleman is doubtful on the subject of my lecture, or thinks that I have stated what cannot be supported, I hope he will speak, in order that the truth may come out, whatever else may happen (cheers).

The Chairman said: Gentlemen, I am sure I express the sentiments of every one present when I tender to Mr. Nesbit, on behalf of the company, our hearty thanks for the lecture which he has delivered to us (cheers). Before we separate, many of us may have some questions which we may be desirous of putting. I would just remark at this moment that Mr. Nesbit comes here at his own expense: he does not put us to any expense whatever for the lecture; and I do not think he ought to bear any expense whatever in the shape of travelling expenses.

Mr. Nesbit: I would much rather appear before you, sir, free from any incumbrance. I like to come independently, and I never will appear amongst farmers for the purpose of receiving remuneration from them.

The Chairman: Allow me to say, Mr. Nesbit, that we are now dependant on you, and what we desire is, that the independence should be reciprocal (Hear, hear).

Mr. Nesbit: There is one subject which I desire to introduce: it is the necessity of your having a farmers' club. Since my first lecture in this neighbourhood there have been already formed one at Alton, one at Guildford, and one at Dorking: and why should there not be one here (Hear, hear)? There are many reasons why farmers' clubs are necessary. It is well known that in large towns there is more interchange of ideas in a day than there is in rural districts in a week; but why should there not be the same interchange of ideas in the country as in the towns? If ever there was a time when it was necessary that farmers should league together, the present is such a time. You find that manufacturers have their chambers of commerce, and everything that is requisite to give them united power; and why should not farmers have similar advantages (Hear, hear)? There is some talk about the repeal of the malt-tax. Well, if you want anything that may be attained by proper means, why do you not unite for the purpose of securing it? If there is any benefit which Parliament can confer upon you, or which science can confer upon you, why should you be deprived of it (Hear, hear)? I happened to dine last Thursday night at the Farmers' Club in London: landlords and farmers were in the room; and one great subject discussed was the necessity of union in spreading farmers' clubs; a necessity which I have urged for years. Farmers require to be more united than they are; they are generally too distrustful of one another—(Hear, hear)—and if farmer A. thinks he has discovered a little secret which will enable him to grow corn better than farmer B., he will hide it from his neighbour (laughter). This feeling will not do. If a farmer gets a new idea, he ought to go to his neighbour and say to him, "There is something which I have discovered: you take it, because we shall all be better if this succeeds; there will not be a single loser, every one will be a gainer." By union you would be more apt to gain information and to receive mutual benefit than by remaining as you do apart. I think that if you were to form a club, not for political purposes, but purely for advancement in agricultural knowledge, you would receive great advantage. I shall feel very great pleasure in seeing a farmers' club established in Farnham; and shall be very happy to come down to communicate to the members any scrap of knowledge that I may chance to possess. Another subject at present of great interest to the farmer is that of "Tenant-right." I am aware that in this part of the country you are happily, by means of your local customs, possessed of perhaps as good a tenant-right as any Act of Parliament could possibly give; but you must recollect that your brethren in other parts of the kingdom are not so fortunately situated (Hear, hear). They have not the same security for their capital invested in land as the landlord has for his capital (Hear, hear). This is a subject of vital importance to the farmers at large; and one that I most particularly recommend to your notice, as we cannot expect good and scientific farming where there is no security for capital invested. There is another point, gentlemen, which I desire to mention. I believe Mr. Charles Attfield has something to say about his hop manure. I have had applications from several parties in London who wanted me to put my name to a hop manure which they wished me to analyze. This, however, I refused to do. I spoke to Mr. Charles Attfield on the subject, and he advised me to put the manure into the hands of a respectable house in London in whom I could confide, in order to save the farmers the trouble of mixing for themselves; because many farmers will not be at the trouble of buying five or six ingredients at different places. I replied, "I will put the ingredients into the hands of a London house, who will mix these things under my directions; and I will answer for their being pure." You can now, therefore, either mix them according to the directions contained in the pamphlet, or you can obtain them already mixed. I have put the affair in the hands of Mr. John Hunt, of Lambeth, a gentleman well known both in London and the country; and I am persuaded that you could not have a person who would supply you with the proper manure at a more reasonable rate.

Mr. Attfield said: Gentlemen, having been called upon by Mr. Nesbit to give you an account of the experiment which I have tried upon my hops, I think it would manifest great ingratitude to him for the kindness which he has shown by his lecture if I were to refuse to make a short statement. I beg to inform you, gentlemen, that I had four acres and three quarters of hops. Last year it was all dressed with stable manure; but I was induced by Mr. Nesbit's pamphlet to try three acres with the manure he recommended. The result was that at an expense of £3 10s. per acre, I grew 435 bushels of hops more per acre than with a dressing of twenty loads of our yard dung at a cost of £12 per acre. I think, gentlemen, that our thanks are due to Mr. Nesbit for recommending to us this manure, which enables us to grow more hops than stable manure; and I believe that if you make the same experiment that I have made, you will find it a very beneficial mode of growing hops (Hear, hear).

Mr. Allden said: One of Mr. Nesbit's pamphlets having fallen into my hands, I saw there a statement of the manure which he recommended as proper for hops; and I tried the manure on two or three pieces of land which had been dunged in the previous year. I picked out an acre here and there, which I acted upon according to the directions. The first thing which I noticed was that my land had a good deal of chick-weed: the weeds soon grew, and where the manure was put, excessively thick. I said, "I think we shall see some hops by-and-bye." The hops, when they came, looked as healthly as possible. I did not go so minutely into the matter as Mr. Attfield did; but I took several friends to the spot, and said to them, "Do you see any difference?" "Well," was the reply, "here is more bine." I asked, "Are there more hops?" and they said, "Yes." The manure held out, the bine being healthy to the last. I am persuaded that this manure did a great deal more good than horse-dung. I applied dung by the side of it, and it did not act so well. I am convinced that it is an excellent manure, and I recommend others to apply it.

The Chairman.—What did the mixture contain?

Mr. Allden.—It contained 3 cwt. of guano, 1½ cwt. of saltpetre, ½ cwt. of gypsum, and 1½ cwt. common salt. The expense was £3 10s. per acre, taking carting and everything else into consideration, and I would certainly recommend others to try it.

The Chairman.—In all the experiments that I made last year I used the carbonate of potash instead of the nitrate, and I confess that I am very much inclined to attribute the difference between the result in my case and in Mr. Attfield's to that circumstance; I believe it was on that account that I did not obtain so good a result. If that be the case, it shows the necessity of applying nitrogen directly to the soil. I dressed ten or fifteen acres last year on one portion of my land. I put on one cwt. of pearl-ash, three cwt. of guano, about 15 bushels of wood-ashes, and two cwt. of gypsum. I put in some places half a ton of guano, from 15 to 20 cwt. of rags, and 20 qrs. of trotters. In every case where I put Mr. Nesbit's mixture the crop was as good as where I had put on the larger quantity: I cannot say the result was better, but the cost was less. I dressed five rows, containing half an acre, with ½ cwt. of pearl-ash combined with 5 bush. of wood-ashes, and in fifteen rows out of twenty I could see a decided difference where I put on 1 cwt. of pearl-ash per acre. Through that strip I put the ton of rags, and 1 cwt. of pearl-ash mixed with 10 bushels of ashes in addition. In a week after, I could see a decided difference. Then I applied a coating of guano, which made a more decided difference. I could not speak positively as to the result, except to sa that the one did quite as well as theother, at a rathery less cost. I still adhere to the opinion that nitrate of potash is better than carbonate of potash.

Mr. Nesbit.—Allow me to say that the carbonate of potash has not yet been much tried—the pearl-ash is caustic, and it may send out the ammonia. You will recollect that the substance which I insisted upon most was silicate of potash. I will get some of that made, and you will then be able to try it. All I endeavoured to do was to get what I could by analysis. I have since analyzed the hop, and found about 4 per cent. of nitrogen in it; that must be derived from something. It is merely a question of expense. In the case of an ingredient derived from the air or from the soil, no doubt if you put more of it in the soil you will not do any harm; but what I want chiefly to guard against is, parties putting one without the other. I speak against putting ammonia, and strong manures of that kind, alone, because I have known an abundance of cases where there was impoverishment of the soil. It is quite possible that the plants do not like the caustic carbonate of potash. The common pearl-ash, perhaps, might act more beneficially if previously converted into carbonate by mixture with soil and exposure to the air. Or I will send you down a little manure with sulphate of potash instead of nitrate; that will soon settle the question. I think what has been stated shows that there is a benefit to be obtained from the potash.

The Chairman: I have not the least doubt of that. Let me say, in allusion to pearlash, that if you put pearlash at all, it ought to be put by itself, and not with guano. I discovered that by experience. I put the pearlash on about three weeks afterwards, and I am perfectly satisfied that what took place to a great extent in the hop kiln will take place also to a great extent in the land. At what time was your dressing put on, Mr. Allden?

Mr. **Allden**: I tried it at different times. I tried two acres at the latter end of February, and when I dug it in I reserved one acre on purpose to dig it in later: the latest dug was decidedly the best. I also beg to state that I have acted on Mr. Nesbit's suggestion as to cutting the bines, and it only cost me about 6s. per acre, with a common chaff-cutting box.

Mr. **Avenell**: I wish to know which is the best season for putting on lime.

Mr. **Nesbit**: In all cases lime ought to be put on as soon as possible. In the north of England they put it on in November. There is then an opportunity for its being slaked and washed into the land, and acting on all portions of the soil. The lime is dug in, and gets into the soil. The sooner you get it on the land for the winter the better. It is much better, too, to put it into the land before the winter than after. Practice will assist you in forming a judgment; but my experience is this, that if you put it into the land after the manure it will drive off the ammonia, whereas it will not do so if you put it there before. It will have time to become mild. Let me now ask if we can have our chairman's assistance in forming a farmer's club?

The **Chairman**: I shall be very happy to become a member.

Mr. **Nesbit**: We shall want a chairman, sir, and I hope you will consent to be the first.

The **Chairman**: I could not take the chair.

Mr. **Nesbit**: Allow me to say that, in such an important matter, you really should be induced to act for the first year, and other gentlemen would afterwards follow in your steps. I really believe that you could not confer a greater obligation on this neighbourhood than by consenting to occupy that position.

The **Chairman**: I shall be very happy to unite with you, but I really cannot take an active part.

Mr. **Nesbit**: There is always a vice-president to supply your place.

The Chairman having at length given an implied consent, after some further conversation, several gentlemen entered their names as members of the proposed club.

A vote of thanks was then returned to the Chairman, and the meeting separated, much gratified with their evening's lecture.

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